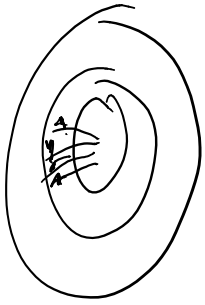
Accuracy and Precision

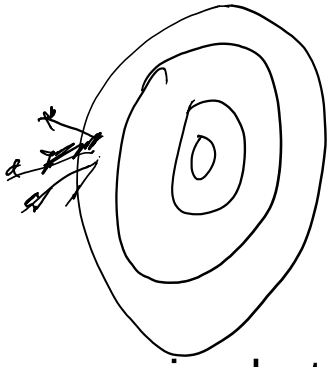
look at archery

arrows are bunched at the bullseye



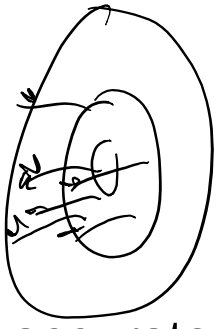
both accurate and precise

arrows are bunched to the side



precise but not accurate

not bunched but centred



accurate but not precise

Accuracy - How close to the "correct" value
- correct is determined by triangulation - multiple measurements in multiple ways

quantify the accuracy by the "deviation from theory" usually given as a percent.

%deviation =|experiment-theory|/theory x 100%

eg. the density of iron is 7.87 g/cm^3, aluminum is 2.70 g/cm^3 and copper is 8.96 g/cm^3. You measure the density of an iron block at 8.31 g/cm^3. What is your % deviation?

8.31-7.87=0.44 0.44/7.87=0.0559
5.6 %

Precision- When you do repeated measurements, what is the spread of the values?

Make sure in all labs (time permitting) you take at least 3 repeats of each measurement, at different times.
eg.
you measure the width of a block 15.9 cm, 16 cm, 16.2cm
range of values is 0.3 cm
uncertainty +/- 0.2 cm
16.0 cm +/- 0.2 cm
15.9+16+16.2=48.1 48.1/3=16.0333

the number of digits is limited by the uncertainty of the measurement.
don't write 16.0000000 +/- 1
16 +/-1

the uncertainty is also related to the smallest division on the measuring device. eg a ruler has a smallest division at mm, so you should try to measure to at least the mm, and you can guess at the next digit.

number of digits can imply the uncertainty.

Labs: always give the uncertainty explicitly in your data table - write +/- with your estimate
compare your estimate to the range of values in the repeated measurements

analogue devices - half the smallest division
digital device - smallest unit
but other factors come into play
eg. stopwatch - reaction time limits precision to the tenth of a second.

sig fig rules:
all non-zero digits are significant
eg. 2376.4 has 5 significant digits, sig figs

zeros in the middle or after a sig fig and after the decimal are significant
eg. 303.0 has 4 sig figs

zeros for placevalue are not significant
0.000034 has 2 sig figs
3.4×10^{-5} has 2 sig figs
200 has unclear sig figs, to be safe use 1 but

multiply and divide - round the answer to the least number of sig figs in the products

23.45679 x 1.0 = 23.45679 round to 23, 2 sig figs

Add /subtract - round the answer to the least precise decimal place (same units and power)

eg. 8.31 g/cm^3 - 7.87 g/cm^3 = 8.31-7.87=0.44

leave it at 0.44 g/cm^3
precise to the hundredth

Lab (not formal no report)
calculate the density of a metal block using
electronic balances (2 in the chem section)
and using
1 a ruler
2 a Vernier caliper
3 a micrometer and Vernier caliper

calculate the % deviation from the values given
for each method
sig fig worksheet